

PROPOSAL TO JOINT FIRE SCIENCE PROGRAM: RFP 2001-1.

April 16, 2001

Project Title: Effects of Fuels-Reduction and Exotic Plant Removal on Vertebrates, Vegetation, and Water Resources in Southwestern Riparian Ecosystems.

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ABSTRACT. Fuel reduction treatments are needed in southwestern riparian ecosystems. The middle Rio Grande riparian bosque (woodland) in Sandoval, Bernalillo, Valencia, and Socorro Counties, New Mexico, is a prime example of a system where fuel reduction is needed to prevent further spread of wildfire in southwestern riparian woodlands, and to reduce risks of fire damage for residents of Albuquerque, Socorro, Belen, Isleta, Sandia, Cochiti, and surrounding rural areas. Dead and downed wood and exotic woody plants comprise fuels leading to high bosque fire risk. Research will identify fuels-reduction practices that will simultaneously preserve cottonwoods and other native plants, reduce wild fire risk via fuels removal, control spread of exotic woody shrubs, and have positive or neutral impacts on wildlife species. Three treatments will be compared: 1) Mechanical removal of dead and down wood and exotic plants, 2) Partial mechanical removal of dead, down, and exotics followed by light prescribed fire, 3) Mechanical removal of dead, downed, and exotics followed by revegetation with native plants. Our proposed study evaluates treatment effectiveness at 16 sites over 4 counties by monitoring water quantity, soil salinity, habitat structure, plant reproductive response, and bird, bat, and herptile populations. This study addresses Task 3 of the RFP “*Within the matrix of land management practices, determine the cumulative effects of fuels manipulation/reduction methods....*” Specifically we target Element 1 of Task 3, “*address fuels treatment impacts on wildlife populations and habitat structure, hydrology, soils, ecosystem health, or other environmental variables at a landscape or regional level.*”

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INTRODUCTION

Project Justification

We propose to monitor vegetation, bird, bat, reptile, and amphibian, and hydrological responses to 3 fuels removal treatments in the middle Rio Grande bosque (woodland). A Memorandum of Understanding (MOU) that defines collaboration among federal, state, and municipal agencies and specifies organizational roles, authorities and contacts has been signed by all parties. This study is conducted under the auspices of the Middle Rio Grande Ecosystem Management Research Program (<http://www.fs.fed.us/rm/albuq>) which is managed by the Rocky Mountain Research Station's Albuquerque Laboratory in collaboration with University of New Mexico, Cibola and Santa Fe National Forests, U.S. Fish and Wildlife Service's Southwest Region, Bureau of Reclamation, City of Albuquerque, and New Mexico Energy, Minerals and Natural Resources Department.

Removal of fuels in the form of dead and downed wood and exotic invasive woody plants is needed in southwestern riparian ecosystems. A prime example of this need is the middle Rio Grande bosque, where fuel reduction would: 1) prevent further spread of catastrophic wildfire, 2) control escalating costs and labor of bosque firefighting, 3) reduce risks of fire damage for residents of Albuquerque, Socorro, and Belen, and surrounding rural areas, and 4) preserve native riparian plant and animal communities. Exotic salt cedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) as well as dead and down wood are fuels that have led to increased fire frequency and risk on the middle Rio Grande (Stuever 1997). Several agencies have engaged in local case-by-case actions to reduce bosque fuels and control exotics, and share their results at Middle Rio Grande Bosque Consortium (MRGBC) meetings.

Treatments that remove invasive woody shrubs from southwestern riparian ecosystems, however, have unknown consequences for wildlife species, including sensitive, threatened, and endangered vertebrate species known to inhabit Rio Grande woodlands. Comparing wildlife, vegetation, and abiotic responses to a variety of treatment types is essential for determining which treatments are least ecologically costly and most advantageous in reducing fire risk while sustaining biological diversity, sensitive species populations, and ecosystem functioning.

Objectives

We propose to study responses of vegetation, birds, bats, herptiles, and hydrology to fuel removal treatments in middle Rio Grande woodlands having cottonwood overstories and high fuel loadings of dead wood and exotic woody shrubs and trees. Research is directed toward identifying best fuels-reduction and exotic plant removal practices that will simultaneously 1) preserve cottonwoods and other native trees and shrubs, 2) reduce catastrophic fire risk via control of exotic plants, and 3) have positive or least-negative impacts on native wildlife species. Each treatment was designed to attain fuel-loading levels estimated to avert catastrophic fire risk. Three treatment types were determined: 1) Mechanical removal of dead and down wood and exotic plants (cut stumps of exotics treated with herbicide), 2) Partial mechanical removal of dead, down, and exotics (herbicide) followed by prescribed fire, and 3) Mechanical removal of dead, downed, and exotics (herbicides) followed by revegetation with native understory plant species such as New Mexico olive, coyote willow, seep willow, wolfberry, and saltbush.

Background

Exotic and Native Plant Issues

Replacement of native vegetation by exotic plant species, particularly those that are highly flammable such as Tamarisk, has increased fire frequency in southwestern riparian ecosystems (Southwestern Willow Flycatcher Recovery Team (SWFRT), 2000). Native tree species inhabiting the middle Rio Grande such as Rio Grande cottonwood (*Populus deltoides* subsp. *wislizeni*) and Fremont cottonwood (*P. fremontii*) are not fire-adapted and thus cannot resist fire damage or respond with regenerative resilience to fires (Abrams 1986, Adams et al. 1982, Busch 1995). The probability of fire is enhanced by river regulation because of the propensity for flammable biomass to accumulate on regulated, flood-suppressed rivers such as the Rio Grande (Busch 1995, Shafroth 1999).

Dewatering of rivers and flood suppression increases the frequency and intensity of fires by increasing the amount, distribution, and flammability of surface fuels (Ellis et al. 1998). Reduced base flows, lowered water tables, and less frequent inundation can cause plants to lose water content, and cause mortality of stems or whole plants. Stress-related accumulation of dead and senescent woody material is a primary factor contributing to fire increase in riparian systems (Busch 1995, Busch and Smith 1995). Dewatering also facilitates the replacement of broad-leaved riparian vegetation by more drought-tolerant species such as tamarisk (Smith et al. 1998).

Tamarisk plants have many stems and high rates of stem mortality, resulting in an accumulation of dense, dry dead branches. Large amounts of litter, including dead branches and the small, needle-like leaves, are caught in the branches, enhancing its flammability. Fallen leaves of the native broadleaf trees (e.g., *Populus* spp. and *Salix* spp.) decay quickly relative to tamarisk, thus reducing the relative fuel loading (SWFRT 2000). Anderson et al. (1977) noted that 21 of the 25 tamarisk stands they studied had burned in the prior 15 years. When dense tamarisk stands burn, the fires are often intense and fast moving. For example, during just 3 years, recent fires totaled 1,000 ha of riparian habitat along the Lower Colorado River – a substantial amount considering only about 6,200 ha of suitable bird habitat currently exists along this river (U.S. Bureau of Reclamation 1999), down from 36,000 ha in 1983 (SWFRT 2000).

Brothers (1984) attributed increased frequency of fires along the Owens River to increased human use of riparian areas. Wisenborn (1996) reported that wildfires in tamarisk were increasingly common owing to increased population densities along rivers. Increased fires in desert uplands also may contribute to riparian fire increase. Grazing-adapted, exotic annual plants spread fire more readily than native annuals and have become established in southwestern deserts and grasslands (Brooks 1995), contributing to increased loads of dry, fine fuels and heightened ignition rates.

Bird, Bat, and Herptile Issues

Numerous Neotropical migratory bird species are ranked as management priorities by Partners in Flight (PIF), a national consortium of government and private groups that supports bird conservation. New Mexico PIF identifies restoration and protection of riparian habitats as an essential step in conserving Neotropical migrants, several species' populations of which are reported by Breeding Bird Surveys to be declining. Mid-story and canopy-nesting Neotropical

migrants that could be affected by catastrophic fire include the Yellow-billed Cuckoo, a bird species repeatedly petitioned by environmental groups to be federally-listed as Threatened or Endangered (see *positive finding to list*, 1999 Federal Register). Short-distance migrants such as Spotted Towhee and Song Sparrow may also respond numerically to treatments that remove midstory habitat structure. Some ground and shrub-nesting Neotropical migrants that could be potentially affected by removal of exotic plants or downed wood include Black-chinned Hummingbird, Common Yellowthroat, Yellow Warbler, Yellow-breasted Chat, Lucy's Warbler, Summer Tanager, and Blue Grosbeak.

Removal of standing snags and mature exotic woody plants could conceivably have either positive or negative effects on canopy-nesting and canopy-foraging migrants such as Black-headed Grosbeaks, Summer Tanager, Yellow-billed Cuckoo, Western Wood Pewee by opening the canopy and removing perch sites. Such treatments may also alter quantity and composition of food supplies (e.g., foliage arthropods, bark beetles), but without research, it is impossible to know whether consequences for birds would be positive or negative. Removal of dead wood, especially standing snags, to reduce fuels may eliminate critical nest sites and foraging substrates for cavity-nesting birds such as woodpeckers, Bewick's Wren, Ash-throated Flycatcher, and Violet-green Swallow.

New Mexico supports up to 26 species of bats, of which 2 are federally endangered and 13 are federal Species of Concern (former USFWS Category 2 candidate species). The high degree of bat species diversity in the Southwest is reflected by the occurrence of over half of the known North American bat species in New Mexico and Arizona. The federal status of over half of New Mexico's bat fauna indicate that bat populations in the state may be threatened or need to be more thoroughly evaluated.

Along the middle Rio Grande, riparian forests and open water are commonly used by many bat species for feeding, roosting, and commuting. Despite their importance in ecosystems as the primary nocturnal predators of insects, bats have been paid very little attention historically by researchers or managers. Thus it is not known how bat communities and activities have been altered in response to nonnative plant invasions, fragmentation of riparian forests, agriculture, urbanization, or other anthropogenic changes along the middle Rio Grande. Given the current federal status of many bat species in New Mexico, it is critical to understand the impact of land management activities on bat populations. Changes caused to cottonwood forest structure and composition by removal of understory invasive plants and dead wood will likely impact the use of these forests by bats. These impacts must be identified, evaluated, and weighed against the merits of invasive plant control and fuels reduction. The objective of the bat component of this project will be to determine and compare the effects of various exotic plant removal treatments on bat activity in and use of mature cottonwood forests with high understory fuel loadings.

The objective of the herpetofauna component of this project is to determine the effects of invasive plant removal treatments on species richness and relative abundance of herpetofauna in mature cottonwood forests with high densities of salt cedar and Russian olive and high fuel loadings. We focus on herptiles, particularly ground-dwelling reptiles, because they are a diverse taxonomic group in the Southwest whose local presence and distribution in the bosque may be influenced by retention or clearing of low vegetation cover and dead wood. From these findings, we will develop recommendations to mitigate the impacts of exotic plant control on herpetofaunal communities.

MATERIALS AND METHODS

Collaborative Arrangements

This study is conducted in coordination with Middle Rio Grande Conservancy District (MRGCD, a state-managed irrigation district), New Mexico State Forestry (NMSF), City of Albuquerque Open Space (ALBQ), Bosque del Apache National Wildlife Refuge (BNWR), Bureau of Indian Affairs (BIA), Pueblo of Cochiti, and Natural Resources Conservation Service (NRCS). Representatives from these organizations serve as regular members of the “Bosque Fuel-Reduction Team” which has been meeting monthly since January 2000 to coordinate treatment plans, NEPA processes, grant-writing, field tours, access, letters of agreement, MOU, and authorizations for this research project. Other cooperators include U.S. Fish and Wildlife Service (hosted a NEPA-writing workshop for the team), Bosque Improvement Group (sponsoring mechanical treatments); Albuquerque Corps of Engineers, U.S. Forest Service Southwest Region, Bureau of Land Management, Save our Bosque Task Force, and Tree New Mexico.

Study sites are located on lands managed by MRGCD, the City, BNWR, and Pueblo of Cochiti. These land-managing agencies are financing and arranging manual labor to clear exotic vegetation, apply herbicides, implement prescribed fires, prepare documents in compliance with regulatory requirements, and permit access to sites. NRCS will implement the revegetation component of treatments. NMSF will supervise and coordinate Inmate Work Crews to clear vegetation at MRGCD sites, BIA will arrange internal crews to remove fuels at Cochiti, and Bosque del Apache will remove fuels using personnel from the U.S. Fish and Wildlife Service. A Memorandum of Understanding (MOU) between the RMRS, land-owning entities, and NRCS Plant Materials Center (PMC) clarifies organizational roles, authorities, and contacts and is enclosed as an appendix. A separate agreement between RMRS, BIA, and Pueblo of Cochiti is being prepared which is similar in scope. The Counsel and Governor of Cochiti voted to approve the project on pueblo property in August, 2000.

Site Selection

Sites were selected in winter and spring of 2000 by using maps to find habitat patches of sufficient size, visiting each to evaluate habitat structure, plant species composition, and fuel loads (Table 1). Livestock are excluded from sites although cattle occasionally trespass at two locations.

Table 1. Study sites that meet site-selection criteria (> 20 ha, high fuel loads). Block 1 refers to Bernallilo Co, Block 2 Valencia Co., and Block 3, Socorro Co.

Block	Land Manager	Location	Site #	Ha	Location Description
1	Albq,MRGCD,NMSP	South Valley	1	28	S Rio Bravo-N I25 W
1	Albq,MRGCD,NMSP	South Valley	2	30	S Rio Bravo-N I25 W
1	Albq,MRGCD,NMSP	South Valley	3	23	S Rio Bravo-N I25 W
1	Albq,MRGCD,NMSP	South Valley	4	25	S Rio Bravo-N I25 E
2	MRGCD	Bosque Farms	1	25	N NM6 S Isleta Pueblo E
2	MRGCD	Los Lunas	1	48	S NM6 S Los Lunas W
2	MRGCD	Los Lunas	2	46	S NM6 S Los Lunas W

2	MRGCD	Bernardo	1	40	N US60 E Bernado Rfge W
3	MRGCD	Bernardo	2	40	N US60 E Bernado Rfge W
3	BLM,MRGCD	Lemitar	1	33	E of river South of Lemitar
3	USFWS	Bosque del Apache	1	31	Management Unit 7
3	USFWS	Bosque del Apache	2	20	East of willow Deck
4	Cochiti Pueblo	Below Cochiti Dam	1	22	W of Rio 0.2 mi S on NM22
4	Cochiti Pueblo	Below Cochiti Dam	2	25	W of Rio 1 mi S on NM22
4	Cochiti Pueblo	Below Cochiti Dam	3	23	W of Rio 2.1 mi S on NM22
4	Cochiti Pueblo	Below Cochiti Dam	4	28	W of Rio 3.3 mi S on NM22

To find enough sites for this research, plots were established across multiple ownerships. Treatments will be applied by cooperating agencies. To conduct 3 treatments, 16 plots have been selected for monitoring purposes (Fig 1.). There will be 4 replicates of each treatment to ensure statistical power. To summarize, total number of plots will equal 4 replicates x 3 treatments + 4 controls = 16 plots. One replicate of each treatment will be located in each of 4 blocks. These blocks (Cochiti, north, middle, and south) each sample a geographically distinct reach of the middle Rio Grande. Each plot must be in habitat patches ≥ 20 ha to ensure accurate sample sizes and monitoring goals for mobile bats and birds. Treatment plots may be adjacent to each other (with habitat buffers between plots) in patches that are large enough to have two or more plots.

Treatments. Treatments will be applied after two seasons of data collection. Fuel loads at sites are in the process of being measured by New Mexico State Forestry (NMSF), and costs of treatments will be based on tons/acre of fuels. Cost estimates for removing (cutting) all dead and down wood and exotics range in the Rio Grande bosque (NMSF pers. comm.) from \$141/ha for 10 ha to \$264/ha for 26 ha depending on tonnes/ha (tons/acre) of fuel loads at a site. Estimates include directed (non-aerial) basal application of Garlon 4 to cut stumps of woody exotics by licensed applicators. Garlon 4 is a selective herbicide proven effective in treating salt cedar and Russian olive with little or no impact on desirable plants or water (Parker and Williamson 1996). U.S. Fish and Wildlife Service (USFWS) and BIA fire crews will implement prescribed fires at sites designated for fire follow-up treatments. Two fire sites are on MRGCD (irrigation district) land and will be implemented under pre-arranged MOUs between MRGCD and U.S. Fish and Wildlife Service. The estimate for revegetation is \$70,000/site of which \$20,000 will be funded through NRCS partnerships and the remainder financed through this proposal and/or by land-owning agencies and funding organizations such as but not limited to U.S. Fish and Wildlife Service's Bosque Improvement Group, U.S. Forest Service, Southwest Region's State and Private Forestry, and Albuquerque Corps of Engineers.

Fuel Loading and Removal. Trained crews supervised by NMSF, BIA, and BNWR will remove dead, down, and exotic woody plants according to fuel-loading targets and treatment types that meet estimated levels necessary to avert fire risk (Wicklund 1999). Selected bosque sites in need of treatment have fuels ranging from 360-450 tonnes/ha (160-200 tons/ac). Prescriptions to avert catastrophic fire risk range from 11 to 68/tonnes/ha (5-30 tons/ac) depending on type and depth of fuel. A range of 5-8 snags/ha will be retained. Fuel loading will be determined in tons/acre by NMSF using the Handbook for Inventorying Downed Woody

Material by James K. Brown (USDA-FS GTR-INT-16, 1994). The handbook provides a detailed description of how to inventory fuels using the Planer Intercept Method. This method involves sampling data planes placed throughout the sample area with dead, down, and exotic woody material being counted and measured. Volume is estimated; then weight is calculated from volume by applying estimates of specific gravity of woody material sampled.

A randomized block design will be used to treat sites, with 4 sites in each of 4 reaches. Treatments will be applied in winter and early spring, prior to May when wildlife sampling begins, and when conditions are safe (e.g., damp soils) for controlled burning. We estimate that it may take two years to implement all treatments. Treatments will be completed the same year within blocks to control for the impacts of random temporal variation. Treatments will be selected randomly by site. Modifications in treatment sites may be needed to meet revegetation requirements and to mitigate public concerns about prescribed fires.

Prescribed Fire. A Prescribed Burn Plan has been developed by qualified agency personnel, and the prescription will be applied to each of the 4 burn sites. To ensure consistency in meeting research fire specifications at each site, Fire and Forestry Supervisor Cal Pino, Bureau of Indian Affairs and Fire Officer Jim Sullivan, U.S. Fish and Wildlife Service have agreed to jointly oversee implementation of fire prescriptions. Funding for prescribed fire projects have been requested by agency fire personnel through normal agency avenues. Resources such as crews, equipment, consultations for implementing fires and mechanically removing hazardous fuels will be shared as authorized under existing MOUs and Joint Powers Agreements. Burning will be preceded by mechanical reduction of 75% of fuels. Objectives of mechanical clearing done in conjunction with fire are to remove live exotics, remove ladder fuels, and to ensure discontinuous distribution of fuels. A specific goal of low-intensity prescribed fire in this context is to open soil surfaces to encourage seeding, suckering, and growth of native plants in the absence of exotics. Our test is to determine if prescribed fire enhances the ability of native plants to re-seed after exotics have been removed. We also hope to determine whether fire can sometimes be used in place of revegetation (which is much more expensive) to return a site to a native understory. To protect live native trees, all fuels will be removed in a circle around them.

Site-specific prescription guidelines are addressed in the Fire Burn Plan with details describing work to be accomplished and methods used. To apply prescribed burning in the bosque, weather and fuel conditions must meet specific criteria (see below) for the project to be successful. Because cottonwood and willow stands have low tolerance to intense heat from fire and because the presence of salt cedar produces fire volatility, precise burning conditions are required so that fire does not damage the residual stand or escape containment.

A major objective is to remove dead, down and duffy material without building up too much heat in and around residual stands and not allowing fire to ignite ladder fuels and move into crowns of residual stands. Burning will be accomplished during the dormant season between November and early March when live fuel moistures are very low (25 – 50%). Air temperatures in the range of 35 to 60 degrees will be targeted. Relative humidity should be in the high range (50 to 100% for piles, 40 to 60% for broadcast burns), winds should be in low (0 to 10 mph), soil moisture should be high with light snow cover being beneficial when burning piles.

Since there will be a large amount of smoldering and creeping fire behavior during the 24 to 48 hours after ignition due to the hard wood duff and slash, we will emphasize burning when

there is a 50% chance of measurable precipitation within the 2- 4 day period following the burn (either pile or broadcast). Patrols will be arranged on a daily basis.

Revegetation. Local ecotype shrub vegetation will be planted by Natural Resources Conservation Service (NRCS) on 4 of the 20-ha treatment plots. Because the Rio Grande Valley receives less than 20 cm of annual moisture, the vegetation will be installed as dormant 4.5 m pole cuttings or as containerized transplants with 74 cm rootstock. This vegetation will be planted in holes that have been augured to the capillary fringe of the water table. Subsequently, the plants should not require any irrigation treatments, which is normally required for one-gallon transplants to obtain satisfactory survival. To adequately reach subsurface moisture, the relatively short 75 cm rootstock will be limited to planting near the river. The 4.5 m cuttings can be planted randomly within the plots.

The NRCS Los Lunas Plant Material Center (PMC) has determined in previous studies that the common Rio Grande riparian shrub species *Amorpha fruticosa* and *Baccharis glutinosa* can be field-established as dormant pole cuttings. The PMC has local collections of both species in farm production. The Rio Grande riparian shrub species *Lycium spp.* and *Forestiera neomexicana* are grown in 10-cm diameter tubes, 75 cm in length, to produce long root systems that can reach subsurface moisture after transplanting. Both species produce fleshy fruit that are readily consumed by many wildlife species including birds.

For enhancement of vegetation establishment, both soil salinity and depth to water table measurements will be taken on each of the 20-ha study plots. Each plot will be divided into quadrants. A well will be installed in the approximate center of each quadrant to monitor the water table depth. A composite sample of 30 soil samples taken from a 15 – 25 cm depth will be collected in each quadrant and measured for electrical conductivity to estimate total soil salts. Extreme salty and dry areas will not be planted.

The PMC will contribute \$20,000/year of in-kind services of plant materials and personnel hours towards this project. This will include the 75 cm tube transplant (@\$20/unit), 4.5 m pole cuttings (@\$8/unit), and personnel hours (@\$250/day). The PMC has the equipment and experience to install shallow monitoring wells and measure soil salinity.

Monitoring Methods

Soils, Hydrology, and Weather. Soils, hydrology and weather are basic environmental parameters that dictate the types of ecosystems found in the Rio Grande Bosque. The treatments proposed in this study could alter conditions in these ecosystems and consequently the habitats of animal and plant species that live there. To determine the effects of the treatments in this study on these environmental parameters, a subset of factors that are vital to animal and plant species will be measured and monitored. The factors are depth to water below the soil surface, the salinity of surface soils, precipitation and air temperature.

Water is critical to the growth and development of all plant species. The primary sources of water for plants growing in the bosque are precipitation, ground water and surface water. Water flowing in the Rio Grande is the primary source of surface water. River water is also the primary source of ground water recharge for areas along the bosque due to the porous nature of the soils and subsurface materials. Water levels in the river are regulated by human-operated dams and generally only vary seasonally.

Contact with a permanent water source is critical to many riparian plant species for germination, early growth years and/or throughout their lives. Rapid changes in the depth to water can kill existing plants and/or create unfavorable conditions for new plants. Therefore it is necessary that we determine the effects our treatments could have on the depth to water in our project areas. To accomplish this, we will monitor the depth to water below the soil surface in 2" (5 cm) diameter piezometers. Each of the 16 study sites will be subdivided into 4 quadrants and one piezometer will be installed in the center of each quadrant. A total of 60 piezometers will be installed for the entire study. The depth to water in each piezometer will be measured and recorded monthly.

Precipitation that falls directly on the bosque in concert with the surface and ground water helps fulfill the needs of the plants and animal species when delivered within regular cycles and quantities. One tipping bucket recording rain gage will be installed at each of the 16 sites to monitor precipitation over the life of the study. Precipitation data will be collected and checked monthly.

Air temperature can influence the amount and location of activities by birds and mammals. Our treatments will affect the amount of shaded and exposed areas, and potentially the temperatures in those areas. Therefore the temperature in one exposed area and one shaded area at each of the 16 sites will be monitored with recording thermometers concealed in weatherproof shields. A total of 32 thermometers will be installed for the study. The data will be collected and summarized monthly.

The amount of salinity in surface soils can adversely affect established and new plants. One treatment is to revegetate selected sites with native plant species. Extensive revegetation work done by the NRCS in New Mexico has demonstrated that high salinity levels in surface soils will reduce the success rate of new plantings. Therefore, salinity level of the surface soils will be sampled at each site. Using the piezometer quadrants, 30 randomly spaced soil samples will be collected from the upper soil surface (15-25 mm below the soil surface). An electrical conductivity measure of the combined samples will be taken to estimate total soil salts. A total of 60 composite samples will be collected and sampled. Revegetation of extremely salty soils will be avoided. Salinity will be sampled prior to treatments. Soil salinity will be sampled again 5 years after treatment.

Vegetation Sampling. A reduction in the amount of woody vegetation from treatment application will result in open space available for establishment and recolonization by native and exotic species. Questions specific to vegetation responses are: 1) what plant community, including what species diversity and composition, will be in place 1-5 yrs post treatment, and 2) will all treatments result in the same plant community? To answer these questions, 1-m square subplots will be established within larger 0.04 ha plots at the plot center and midway along each of the 4 cardinal-direction radii. A minimum of 10 subplots will be sampled at each site. Within the subplots, density and cover of all vascular plant species will be recorded.

To assess changes in bird habitat in relation to treatments, vegetation structure at each site will be characterized by using 0.04 ha circular plots (James and Shugart 1970). One plot will be centered on each bird point count location. Random plots and avian nest sites will also be sampled and used to characterize the vegetation surrounding nests in relation to random habitat availability. In each plot the number of woody stems of each species will be counted by

diameter-at-breast height size classes before and after treatment. After treatment, health of remaining woody vegetation will be assessed by estimating percentage of live, standing dead, and dead and down biomass. Ground cover that contacts a vertical rod will be recorded at 25 points spaced at 20 cm intervals along each of 4 radii of the sampling plot. The radii will be oriented in the cardinal directions. All grasses and herbs will be recorded to species where possible. Ground cover diversity will be estimated at 2 m intervals along each radii by counting the number of times vegetation hits a vertical rod in a series of 1 dm height categories. Foliage diversity of shrubs and trees will be estimated by counting the number of times foliage hits a vertical rod in 2 m height categories. Canopy closure will be measured with a densiometer at the point center and the end of each radii.

Vegetation surveys for herptile and bat studies will include variables that assess the degree of ground clutter/cover for herptiles, obstructions to bat flight below the canopy, and availability of snags and damaged trees for bat roosts.

Bird Sampling. Breeding birds will be monitored by a crew of 6 persons from 15 May through 15 July at all study sites. Approximately half of their time will be spent counting birds, searching for nests, and monitoring nests and behavior. The remaining half of the time will be spent measuring vegetation, mist netting, and monitoring hydrologic conditions. USFWS has issued permits to RMRS to survey southwestern willow flycatchers in the bosque. Sites occupied by breeding flycatchers will not be included in the study in accordance with guidance in the draft flycatcher recovery plan.

Generally, our count methods follow the recommendations of Bibby et al. (1992). Point-count stations will be placed at a density of 1 per 4 ha. Birds will be counted at each site 4-5 times per season. During each count, all birds seen or heard will be recorded at each point for 8 minutes. Each counter will be trained to estimate and record distances in meters. Each site will be searched for nests on 4-5 occasions during between 15 May and 15 July. The contents of accessible nests will also be checked regularly. The location of each nest will be recorded via global positioning system (GPS).

Bat Sampling. To identify impacts of treatments on summer activity levels of bats, relative changes in bat activity at each site will be quantified. One to two years of pretreatment data will identify the inherent differences in bat activity between control and treatment sites due to site differences. Treatment effects will be identified as significant changes in the magnitude of these differences.

From night to night, bat activity depends on weather conditions, moon phase, insect activity, and other factors. To reduce this temporal variation, the multiple sites in a block will be monitored simultaneously in a single night. One block will be monitored per night, and each block will be monitored once per week from June 5 through September 1. The order of sampling each week will be randomized. Thus each site will be monitored 12-13 nights per season. Three bat-monitoring stations will be established per site. All monitoring stations will have their GPS locations recorded, will be marked with flags, and will be reused each year. On the night a site is to be monitored, automated echolocation-monitoring devices will be set up at the stations and activated just prior to dusk. Bat activity will be reflected by an index of abundance (IA) which is

the total number of passes recorded in a night. A pass is defined as a sequence of ≥ 1 echolocation pulses with < 1 s between sequential pulses.

To determine whether prey abundance is correlated with changes in bat activity, the relative abundances of moths, beetles, and chironomids, the primary prey of many bat species, will be evaluated pre- and post-treatment. Arthropods will be collected in blacklight traps placed near acoustical monitoring stations on the same nights as monitoring. Moths and beetles will be sorted into size classes, and dry weight of each size class will be determined.

Reptiles and Amphibians. To identify impacts of treatments on reptile and amphibians, species richness and relative abundance will be quantified at each of the sites prior to and post-treatment. The direction and magnitude of changes on treatment sites will be compared to the control sites. Other factors that will be included to explain potential variation include block and year. To evaluate species richness and relative abundance, reptiles and amphibians on each site will be trapped with three drift fence arrays. Arrays will be placed randomly within the site and at least 25m from the periphery. Sites at each block will be trapped for 1 day per week from 1 May through 1 September. Each drift fence array will consist of three silt erosion fences with 2 pitfalls and 2 funnels per fence. Each fence will be 7.5 m long, will start 7.5 m from a central point, and will be positioned at an angle of 60 degrees from the other fences. For each day of trapping, we will record site number, array number, date, time, collector's name, species caught, which trap, snout-vent length, total length, mass, sex, and age. The cumulative number of species captured over one season will be tallied to determine species richness at a site. Each year's relative abundance will be reflected by a trapping rate (e.g. numbers per trap night).

Data Analyses

Analysis of variance with a randomized block design will be used to evaluate effects of treatments on wildlife numbers, vegetation variables, and avian nesting success. Power analyses to determine influence of variability among sites within blocks, within sites, and over time will be applied to ensure adequate sample sizes of wildlife data. Modifications of numbers of bat detectors, bird point counts, and habitat samples per site will be made during the first pre-treatment year, if power analyses dictate revisions in sampling design. Exploratory specialized sampling that varies number of bat detectors/site will be conducted to determine adequate number of bat samples.

PROJECT DURATION

We established sites in 2000 and tested monitoring methods in May-September 2000. A minimum of 2 years of pre-treatment monitoring (Years 2001-02) of birds, bats, herptiles, and hydrology will be followed by 2 years of treatment (2002-03) and at least 3 years of post-treatment sampling (2004-07) to determine short-term effects on flora, fauna, and hydrology. Sampling of flora and fauna will be conducted each year from May 15 to September 30. Hydrological and weather monitoring will be continuous through each year. To evaluate long-term efficacy and impacts of treatments, monitoring will continue to be conducted in 5-year intervals. For the purposes of this budget request, we seek funding for Fiscal Years 2001-2004 (3 calendar years starting Summer 2001).

BUDGET

Treatment costs will be sponsored by FWS, BIA, MRGCD, and ALBQ. NRCS PMC partners will contribute \$20,000/yr for revegetation. ALBQ is also supplying \$5,000/year for equipment purchases. RMRS requests the following funds/year:

Year	Cooperators**	RMRS	JFSP
Year One*	\$50,300	\$164,395	\$111,680
Year Two*	\$136,071	\$142,162	\$121,390
Year Three*	\$55,300	\$156,753	\$122,665
Total All Yrs	\$241,671	\$463,310	\$355,735

*A more detailed budget breakout is included in the Appendix.

**NMSF estimates costs for mechanically clearing 240 Ha at \$33,739 to \$60,771. Prescribed fires will be sponsored by USFWS and BIA with assistance from other agencies.

DELIVERABLES

The first annual progress report will be delivered electronically and via hard copy by December 30, 2001, followed by annual reports December 30, 2002 and 2003, and a final report by September 30, 2004. Results will be published in peer-reviewed outlets such as *Forest Ecology and Management*, *Restoration Ecology*, and *Ecological Applications*. We envision at least 8 publications, 4 in natural resources journal, and the remainder in specialty journals focused on plants, animals, and water. Upon completion of the project (i.e., years 2001-2007), we will host a conference to report synthesized results and results by specialty (e.g., vegetation, soils/water, bats, birds, and herptiles) and conduct open site visits to illustrate results.

TECHNOLOGY TRANSFER

Demonstration Sites. Our research blocks are designated as “demonstration sites”, and as such will be used on an annual and *ad-hoc* basis to host field tours for those seeking solutions for reducing fuels and removing exotic woody plants from riparian sites in the Western United States. Target audiences include rural landowners in Sandoval, Valencia and Socorro Counties as well as urban residents and managers in Bernalillo County. These landowners include federal, state, tribal and private entities. For example, almost half of the 18 Pueblos in New Mexico are located along the Rio Grande and can benefit greatly from information transferred from this project. Congressional representatives and media representatives will be regularly invited on field tours, and public demonstrations will be announced in the Albuquerque Journal and the Albuquerque Tribune.

Training Workshops. Training workshops will be hosted annually by a combination of collaborating agencies and researchers to demonstrate methods for removing fuels, controlling exotics, measuring fuel loads, setting fire prescriptions, revegetating sites with native plants, alternative restoration methods, monitoring wildlife populations, estimating treatment costs, and writing grants to obtain treatment funds. Workshops will include presentations of research results and visits to demonstration sites.

Meetings and Tours. Information and guidelines will be transferred to MOU cooperators during monthly project meetings and to other managers via consultations, oral presentations at

agency locations, professional meetings and symposia, and via Powerpoint presentations and RMRS technical reports.

WebSites and Newsletters. Preliminary and published results will be posted on the RMRS' web site (<http://www.fs.fed.us/rm/albuq>) and linked to cooperators' websites including but not limited to NMSF: (<http://www.emnrd.state.nm.us>), ALBQ (<http://www.cabq.gov>), BNWR (<http://southwest.fws.gov/refuges/newmex/bosque.html>), and BIA (<http://www.doi.gov/bureau-indian-affairs.html>). Results will also be publicized in the RMRS monthly newsletter and in its quarterly "Publication Announcement" series. Products will be advertised and summarized in the quarterly MRGBC Newsletter, and in the City of Albuquerque's Open Space newsletter. Research findings will be presented at the Bosque Consortium's annual conference, at regular meetings of Bosque Improvement Group and Rio Caucus, and via "Basin Net", an internet mail list service for Rio Grande/Rio Bravo Basin users.

Rotating Posters. One or more posters will be prepared that describe methodology, treatment sites, collaboration, and research results. These will be rotated to workplaces identified by our fuels reduction team, or at request.

LITERATURE CITED

1. Abrams, M.D. 1986. Vegetation 65:29-37.
2. Adams, D.E., R.C. Anderson, & S.L. Collins. 1982. Southwest. Nat. 27:55-61.
3. Anderson, B.W., A. Higgins, & R.D. Ohmart. 1977. Pp. 128-136 *in* RMRS Gen. Tech. Rep. RM-43. Fort Collins, CO.
4. Bibby, C.J., N.D. Burgess, & D.A. Hill. 1992. Academic Press, New York.
5. Brothers, T.S. 1984. Pp. 75-84 *in* California riparian systems: Ecology, conservation, and productive management. UC Press, Berkeley, CA.
6. Brooks, M.L. 1995. Environ. Manage. 19:65-74.
7. Busch, D. E. 1995. Southwest. Nat. 40:259-267.
8. Busch, D.E. & S.D. Smith. 1995. Ecol. Monogr. 65:347-370.
9. Ellis, L.M., C.S. Crawford, & M.C. Molles. 1998. J. Arid Environ. 38:283-296.
10. Parker, D. & M. Williamson. 1996. USDA FS, SW Region, Albuquerque, NM.
11. Shafroth, P. 1999. Ph.D. Dissertation, Arizona State Univ., Tempe, AZ.
12. James, F.C. and Shugart Jr., H.H., 1970. Audubon Field Notes 24:727-736.
13. Smith, S.D., D.A. Devitt, A. Sala, J.R. Cleverly, & D.E. Busch. 1998. Wetlands 18:687-696.
14. SWFRT. 2000. Draft Recovery Plan. USFWS, SW Region, Albuquerque, NM.
15. Stuever, M.C. 1997. M.S. Thesis, Univ. New Mexico, Albuquerque.
16. U.S. Bureau of Reclamation. 1997. L. Colorado Reg. Off., Boulder City, NV.
17. Wicklund, C. 1999. Prescription guide for the Rio Grande Bosque. NM State Forestry, Santa Fe, NM.
17. Wiesenborn, W.D. 1996. Salt Cedar Management Workshop, June 12, 1996. BOR, Boulder City, NV.

DEBORAH M. FINCH
Curriculum Vitae

Address: USDA Forest Service, Rocky Mountain Research Station, 333 Broadway SE, Suite 115, Albuquerque, NM 87102-3497.

Phone: 505-724-3671

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Email: dfinch@fs.fed.us

Web Site: <http://www.fs.fed.us/rm/albuq>

Education:

Ph.D. Zoology, Range Minor, University of Wyoming, Laramie, 1987.

M.S. Zoology and Physiology, Arizona State University, Tempe, 1981.

B.S. Wildlife Mgmt, Range Minor, Humboldt State University, Arcata, CA, 1978.

Professional Experience (Permanent Positions):

1993-Present. Project Leader, GS-14. USDA FS, Rocky Mtn Res. Stn. Albuquerque, NM.

1992-93. Research Wildlife Biologist, GS-13. USDA FS, Rocky Mtn. Forest and Range Exp. Sta., Flagstaff, AZ.

1991-92. Neotropical Migrant Program Coordinator, GS-13. USDA FS, Forest Environment Research, Washington, DC.

1986-90. Res. Wildlife Biol, GS-12-13. USDA FS, Rocky Mtn. Forest & Range Exp. Sta., Laramie, WY.

1981-86. Res. Wildlife Biologist, GS-9-11. Rocky Mtn. For. & Range Exp. Sta., Laramie, WY.

1978-81. Res. Wildlife Biologist, GS-5-7. Rocky Mtn. Forest & Range Exp. Sta., Tempe, AZ.

Narrative Biography: I have been a research biologist employed by the Rocky Mountain Forest and Range Experiment Station since 1978. My research interests include ecosystem restoration using prescribed fire, exotic plant removal, and grazing adjustments; riparian and grassland ecology and health; avian reproductive ecology and habitat relationships; invasive and exotic plants; community ecology; threatened, endangered and sensitive species; and technology transfer. I currently lead two interdisciplinary programs of research on wildlife habitat relationships, biological diversity, and ecosystem sustainability, evaluating vertebrate and plant responses to range, fire, and restoration management, habitat manipulation, and climate change. I manage a Middle Rio Grande Ecosystem unit, and a Southwest Grasslands and Riparian unit.

Selected Grants and Contracts

\$74,600 Grant, 1992-93 for Mexican Intern Program. Tropical Forestry Program, USFS.

\$73,000 Contract, 1991. Forest fragmentation study. Funded by Region 4, USFS.

\$105,000 Grant, 1994-96. Rapid Assessment of BioDiversity, Michoacan, Mexico. LOI, Mexico-U.S. Research, Washington, DC.

\$400,000/yr Grant, 1994-present. Rio Grande Basin Program. F.S. Research., Washington, DC.

\$66,000. 1996-97. Southwestern Willow Flycatcher Migration. Bureau of Reclamation..

\$135,000. 1995. GIS Mapping of the middle Rio Grande. Army Corps, BOR, USFWS.

\$45,000. 1996. Songbirds of Ponderosa Pine. U.S. For. Serv., SW Region, Albuquerque, NM.

\$25,000. 1997. Cryptogam crusts on RNAs in NM. U.S. Forest Service, Washington, D.C.
 \$450,000. 1998-2001. Grazing assessment in the Southwest. U.S. Forest Service, SW Region.
 \$167,000. 1999-2001. Southwestern willow flycatcher surveys. U.S. Air Force.
 \$42,000. 2000. Neotropical Migratory Bird Studies. National Fish and Wildlife Foundation.
 \$200,000. 2000. Evaluating ecosystem responses to grassland fires. National Fire Plan, U.S.F.S.
 \$500,000. 2000. Monitoring fire effects in riparian ecosystems. National Fire Plan, U.S.F.S.

Peer-reviewed Publications: Last Four Years

- Kelly, J.F. and **D.M. Finch**. *In press*. Effects of sampling design on age ratios of migrants captured at stopover sites. *Condor*.
- Finch, D.M.**, and S.H. Stoleson. 2000. Ecology and Conservation of the Southwestern Willow Flycatcher. RMRS-GTR-xx (in press). Ogden, UT: Rocky Mountain Research Station.
- Beissinger, S. R., J. M. Reed, J. M. Wunderle, Jr., S. K. Robinson, and **D. M. Finch**. 2000. Report of the AOU Conservation Committee on the Partners in Flight species prioritization plan. *Auk* 117:549-561.
- Franzreb, K., **D. Finch**, P. Wood, & D. Capen. 2000. Management strategies for the conservation of forest birds. 17 p. Strategies for Bird Conservation. Cornell Univ, Ithaca, NY.
- Thompson, F. R. III, **D. M. Finch**, J. R. Probst, G. D. Gaines, and D. S. Dobkin. 2000. Multi-resource and multi-scale approaches for meeting the challenge of managing multiple species. 13 pp. Strategies for Bird Conservation. Cornell University, Ithaca, NY.
- Finch, D.M.** and W. Yong. 2000. Landbird migration in riparian habitats of the Middle Rio Grande: A case study. *Studies in Avian Biology* 20: 88-98.
- Stoleson, S. H., and **D. M. Finch**. 1999. Unusual nest sites for southwestern willow flycatchers. *Wilson Bulletin* 111: 574-575
- Kelly, J. F., **D. M. Finch**, and W. Yong. 2000. Vegetative associations of wood warblers migrating along the Middle Rio Grande Valley, New Mexico. *Southwest. Nat.* 159-168.
- Finch, D. M.** 1999. Recovering southwestern willow flycatcher populations will benefit riparian health. *Trans. 64th No. Am. Wildl. And Natur. Resour. Conf*: 275-291.
- Finch, D.M.**, J.C. Whitney, J.F. Kelly, and S.R. Loftin. 1999. Rio Grande Ecosystems: Linking Land, Water, and People. *Rocky Mtn. Res. Stn. Proceedings RMRS-P-7*. 245 pp.
- Kelly, J. F., R. Smith, **D. M. Finch**, F.R. Moore, W. Yong. 1999. Effects of summer biogeography on the stopover abundance of Wood Warblers. *Condor* 101:76-85.
- Yong, W., **D. M. Finch**, F.R. Moore, and **J.F. Kelly**. 1998. Stopover ecology and habitat use of migratory Wilson's Warblers. *Auk* 115:829-842.
- Kelly, J. F. and **D. M. Finch**. 1998. Using stable isotopes to track migrant songbirds. *Trends in Ecology and Evolution* 13:48-49.
- Garcia, S., **D.M. Finch**, and G. Chavez Leon. 1998. Patterns of forest use and endemism in resident bird communities of north-central Michoacan, Mexico. *For. Ecol. & Manage.* 110:151-171.
- Finch, D.M.**, J.L. Ganey, W. Yong, R.T. Kimball, & R. Sallabanks. 1997. Effects and interactions of fire, logging, and grazing. RM-GTR-292 (Reviews TWS, COS, AOU).
- Yong, W. and **D.M. Finch**. 1997. Migration of the willow flycatcher along the middle Rio Grande. *Wilson Bulletin* 109:253-26.

Shaw, D.W. and **D.M. Finch**, eds. 1996. Desired future conditions for Southwestern riparian ecosystems. Rocky Mtn. For. & Range Exp. Sta. GTR-RM-272. 359 pp.

Curriculum Vitae

Alice Chung-MacCoubrey

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Research Interests

Mammalian habitat use, resource requirements, effects of habitat alteration, competition, reproductive ecology, physiology and nutrition. Taxa of interest: bats, herps, sciurids, and carnivores.

Education

Doctor of Philosophy (Biology) 2001 (expected)
University of New Mexico, Department of Biology. Dissertation: Maternity roosting habits of *Myotis thysanodes*, *M. volans*, and *M. evotis* in pinyon-juniper woodlands and ponderosa pine forests of central New Mexico.

Master of Science (Fisheries and Wildlife Sciences) 1993
Virginia Polytechnic Institute and State University, Dept. of Fisheries and Wildlife Sciences. Thesis: Effects of tannins on protein digestibility and detoxification activity in gray squirrels (*Sciurus carolinensis*).

Bachelor of Science (Biochemistry) 1988
Highest Honors. Rutgers University, Cook College, Department of Biochemistry.

Professional Experience

1994 - present Research Wildlife Biologist
USFS Rocky Mountain Research Station, Albuquerque, NM.
1995 - present Ph.D Graduate Student
University of New Mexico, Department of Biology, Albuquerque, NM.
1993 - 1994 Wildlife Nutrition Lab Technician
Smithsonian Institution, National Zoo, Dept. Zoological Research, Washington, D.C.
1991 - 1993 M.S. Graduate Student and Research Assistant
Virginia Tech, Department of Fisheries and Wildlife Sciences, Blacksburg, VA.
1991 Wildlife Biologist Trainee- Coop. Ed program
Wallowa-Whitman National Forest, Wallowa Valley Ranger District, Enterprise, OR.

- 1990 Wildlife Biologist - Spotted Owl Research
Oregon State University Coop. Wildlife Research Unit, Dept. Fisheries and
Wildlife, Corvallis, OR.

Professional Experience (cont'd)

- 1988 - 1990 Senior Biochemistry Lab Technician
Robert Wood Johnson Medical School, Department of Pathology, Piscataway,
NJ.
- 1988 North Atlantic Rightwhale Research Assistant
New England Aquarium, Edgerton Research Laboratory, Boston, MA.

Publications

- Chung-MacCoubrey, A. L.** 1999. Maternity roosts of bats at the Bosque del Apache National Wildlife Refuge: a preliminary report. Pp. 187-190 in D. M. Finch, J. C. Whitney, J. F. Kelly, and S. R. Loftin, eds. Rio Grande Ecosystems: Linking land, water, and people. Toward a sustainable future for the Middle Rio Grande Basin. June 2-5, 1998. Albuquerque, NM. Proc. RMRS P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mtn. Res. Stn. 245p.
- Chung-MacCoubrey, A. L.,** A. E. Hagerman, and R. L. Kirkpatrick. 1997. Effects of tannins on digestion and detoxification activity in gray squirrels (*Sciurus carolinensis*). *Physiological Zoology* 70:270-277.
- Chung-MacCoubrey, A. L.** 1996. Grassland bats and land management in the Southwest. Pp. 54-63 in D. M. Finch, ed. Ecology and management of western grassland ecosystems. Gen. Tech. Rep. RM-GTR-285. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 82p.
- Chung-MacCoubrey, A. L.** 1995. Bat species composition and roost use in pinyon-juniper woodlands of New Mexico. Pp. 118-123 in R. M. R. Barclay and R. M. Brigham, eds. Bats and Forests Symposium. October 19-21, 1995. Victoria, BC. Canadian Research Branch, BC Ministry of Forests, Victoria, B.C. Working Paper 23/1996. 292p.
- Chung-MacCoubrey, A. L.** 1995. Bat species using water sources in pinyon-juniper woodlands. Pp. 168-170 in D. W. Shaw and D. M. Finch, tech coords. Desired Future Conditions for Southwestern Ecosystems: Bringing Interests and Concerns Together. September 18-22, 1995. Albuquerque, NM. Gen. Tech. Rep. RM-GTR-272. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 359p.
- Loftin, S. R., **A. L. Chung-MacCoubrey,** R. Aguilar, and W. Robbie. 1995. Desert Grassland and Shrubland Ecosystems. Chapter 5. Pp. 80-94 in D. M. Finch and J. A. Tainter, eds. Ecology and Sustainability of the Middle Rio Grande Basin. Gen. Tech. Rep. RM-GTR-268. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 186p.
- Gottfried, G. J., T. W. Swetnam, C. D. Allen, J. L. Betancourt, and **A. L. Chung-MacCoubrey.** 1995. Pinyon-juniper Woodlands. Chapter 6. Pp. 95-132 in D. M. Finch and J. A. Tainter, eds. Ecology and Sustainability of the Middle Rio Grande Basin. Gen. Tech. Rep. RM-

GTR-268. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 186p.

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Education

Ph.D. in Watershed Management and Soil Science, University of Arizona, Tucson, AZ, 1989.
M.S. in Watershed Management and Soil Science, University of Arizona, Tucson, AZ, 1985.
B.S. in Forest Management, Rutgers University, New Brunswick, NJ, 1974.

Professional Experiences

8/96 - Now Research Hydrologist, Rocky Mountain Research Station, Albuquerque, NM.
1/92 – 7/96 Research Soil Scientist, Rocky Mountain Research Station, Flagstaff, AZ.
6/89 – 12/92 Research Soil Scientist, Rocky Mountain Research Station, Tempe, AZ.
5/84 – 7/89 Watershed Research Assistant, University of Arizona, Tucson, AZ.
8/86 – 5/88 Computer Lab Teaching Assistant, University of Arizona, Tucson, AZ.
8/82 – 4/84 Watershed Research Assistant, University of Arizona, Tucson, AZ.
2/82 – 5/82 Forestry/Soil Conservation Consultant, USAID/Niger, Niamey, Niger (West Africa).
8/77 – 1/82 Project Director/Research Forester, The Research Institute, Strategies for Responsible Development, University of Dayton, Niamey, Niger.
4/77 – 7/77 Forestry and Administrative Consultant, Catholic Relief Services, Niamey, Niger.
10/76 - 3/77 Forestry Consultant, Research Institute, Strategies for Responsible Development, University of Dayton, Dayton, OH and Niamey, Niger.
6/74 – 9/76 Forester, Peace Corps/Niger Waters and Forest Service, Niamey, Niger.
7/71 – 8/72 Natural Resources Counselor, Boy Scouts of America, Plainfield, NJ.
8/70 – 5/74 Forestry Assistant, Rutgers the State University, New Brunswick, NJ.

Publications

Jemison, R. and A. Edwards. 2000. Roads, riparian, restoration. *In*: Beschta, R. and P.J. Wigington, Jr. *eds.* Riparian ecology and management in multi-land use watersheds: AWRA specialty conference proceedings: 2000 August 27-31, Portland, OR. AWRA-TPS-002, Middleberg, VA.

Jemison, R. and C. Raish *eds.* *In Press.* Livestock management in the American southwest: ecology, society and economics. Elsevier Science. The Netherlands. 597p.

Kruse, W. and **R. Jemison.** *In Press.* Grazing systems of the southwest. Chapter 3, Pp. 27-52. *In*: Jemison, R. and C. Raish, *eds.* Livestock management in the American southwest: ecology, society and economics. Elsevier Science. The Netherlands. 597p.

Danzer, S., **R. Jemison**, and D.P. Guertin. *In Press.* Riparian plant communities in the mountains of southeastern Arizona. The Southwestern Naturalist.

Jemison, R. and D.G. Neary. 2000. Stream channel designs for riparian and wet meadow rangelands in the southwestern united states. Pp. 305-306. *In*: Ffolliott, P.F., M.B. Baker

- Jr., C.B. Edminster, M.C. Dillion, and K.L. Mora, *tech. eds.* Land stewardship in the 21st century: the contributions of watershed management: 2000 March 13-16, Tucson, AZ. Proc. RMRS-P-13. Ft. Collins, CO. USDA Forest Service, Rocky Mountain Research Station. 438p.
- Jemison, R.**, D. Neary, and D. Pawelek. 1999. Restoration of mountain rangeland meadows using designed runoff channels. Pp. 698-699. In: Eldridge, D. and D. Freudenberger, *eds.* People and rangelands building the future: Proceedings of the VI international rangeland congress, Townsville, Australia. 1064p.
- Neary, D.G., W.P. Clary, and **R.L. Jemison**. 1999. The Santiago declaration on forest sustainability: soil and water indicators for rangelands. Pp. 703-704. . In: Eldridge, D. and D. Freudenberger, *eds.* People and rangelands building the future: Proceedings of the VI international rangeland congress, Townsville, Australia. 1064p.
- Pawelek, D., **R. Jemison**, and D. Neary. 1999. A constructed wet meadow model for forested lands in the southwest. Pp. 97-99. In: Finch, D., J. Whitney, J. Kelly, and S. Loftin, *eds.* Rio Grande ecosystems: linking land, water, and people. 1998 June 2-5; Albuquerque, NM. Proceedings RMRS-P-7. Ogden, UT. USDA Forest Service, Rocky Mountain Research Station. 245p.
- Jemison, R.** 1998. A model for constructed wet meadows on forest land in the southwest. Pp.113-114. In: Water at the confluence of science, law, and public policy. Proceedings of the 11th annual symposium of the Arizona Hydrological Society, September 24-26-, 1998. Tucson, AZ 251p.
- Jemison, R.**, D.G. Neary, and D. Pawelek. 1997. Re-engineering forest roads to enhance riparian ecosystems in the Zuni mountains of New Mexico. Pp. 803-808. In: Wang, S.S.Y., E.J. Langendoen, and F.D. Shields Jr. *eds.* Management of landscapes disturbed by channel incision, The University of Mississippi, Oxford, MS, May 19-23, 1997. Proceedings. 1134p.
- Jemison, R.** 1996. Re-engineering forest roads to enhance riparian ecosystems in the Zuni mountains of New Mexico. Pp. 53-56. In: Wanted: water for rural Arizona, Proceedings of the 9th annual symposium of the Arizona Hydrological Society, September 12-14, 1996, Prescott, AZ. 203p.
- Tellman B. and **R. Jemison**. 1995. Riparian/wetland research expertise directory: Arizona, Colorado, Nevada, New Mexico, and Utah. Ft. Collins, CO. Rocky Mountain Research Station. 269p.
- Fox, D., **R. Jemison**, D.U. Potter, H.M. Valett, and R. Watts. 1995. Geology, climate, land and water. Chapter 4. Pp. 52-79. In: Finch, D.M. and J.A. Tainter *tech eds.* Ecology, Diversity, and Sustainability of the Middle Rio Grande Basin. Gen. Tech. Rep. RM-GTR-268. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 186p.
- Jemison, R.** 1995. An ecosystem management strategy for sycamore creek watershed in south-central, Arizona. Proceedings of the 39th annual meeting of the Arizona-Nevada Academy of Sciences, April 22, 1995. Flagstaff, AZ.
- Dunn, W. and **R. Jemison**. 1995. Foraging partnerships abroad: the sister forest program. Journal for Forestry 93:28-31.
- Jemison, R.** 1993. Associations between riparian ecosystem parameters in Happy Valley,

- Arizona. Pp. 233-239. In: Riparian management: common threads and shared interests. Albuquerque, NM. February 4-6, 1993. Gen. Tech rep. RM-GTR-RM-226. Ft. Collins, CO. USDA Forest Service, Rocky Mountain Research Station. 419p.
- Baker, M.B., Jr. and **R. Jemison**. 1991. Soil Loss -- Key to understanding site productivity. In: Proceedings: 36th annual New Mexico water conference. Las Cruces, NM, November 7-8, 1991. New Mexico Water Resources Institute, Las Cruces, NM. WRRRI Report No. 265, p. 71-76.
- Jemison, R.** 1989. Conditions that define a riparian zone in southeastern Arizona. PhD. dissertation. University of Arizona, Tucson, AZ. 62p.

Professional Affiliations

Arizona Hydrological Society
Arizona-Nevada Academy of Science
Arizona Riparian Council
International Society of Tropical Foresters
New Mexico Riparian Council
Society of Range Management
Soil and Water Conservation Society
World Association of Soil & Water Conservation

Jeffrey F. Kelly
Curriculum Vitae

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Education

Ph.D. in Zoology, Colorado State University, 1996
M.S. in Zoology, Oklahoma State University, 1991
B.S. in Wildlife Management, University of Maine, 1987

Experience

8/98 - Present **Postdoctoral Research Wildlife Biologist**, Rocky Mountain Research Station
and **Research Assistant Professor**, Department of Biology, Univ. of New Mexico
2/97 - 8/98 **Visiting Scientist** at Rocky Mountain Research Station, Albuquerque, NM
6/96 - 8/96 **Instructor**, Dept. of Biology, Colorado State University
8/91 - 5/96 **Teaching Assistant**, Dept. of Biology, Colorado State University
5/91 - 8/91 **Research Associate**, University of Montana, Missoula, MT
4/89 - 5/91 **Research Assistant**, Oklahoma State University, Stillwater OK
6/87 - 4/89 **Wildlife Technician**, U.S. Fish & Wildl. Serv., Volcano HI
6/86 - 8/86 **Volunteer**, U.S. Fish and Wildlife Service, Anchorage, AK 99503

Research Support 1999-2000

2000 - Are golf courses, hotspots for biodiversity in the desert southwest? J.F. Kelly et al. National Fish and Wildlife Foundation. 3yrs -\$86,400
2000 - Using stable isotopes to link breeding, wintering and migratory populations of Southwestern Willow Flycatchers. USDA, Forest Service, Rocky Mountain Research Station J.F. Kelly et al. \$13,140
2000 - Effects of grazing on habitat use by wintering grassland birds on the Sevilleta NWR. USDA, Forest Service, Rocky Mountain Research Station. J.F. Kelly et al. \$ 11,520
2000 - Habitat use by grassland songbirds relative to grazing management, New Mexico Department of Game and Fish. J.F. Kelly, et al. \$3,000
2000 - Migration and winter habitat use by grassland birds of the Sevilleta NWR, U.S. Fish and Wildlife Service, A.B. Montoya, R. Meyer, and J.F. Kelly. \$10,280.
1999 - Use of stable hydrogen isotopes for tracking migrant songbirds, USDA, Forest Service, Rocky Mountain Research Station. J.F. Kelly et al. \$12,500
1999 - Effects of grazing on habitat use by wintering grassland birds on the Sevilleta NWR, USDA, Forest Service, Rocky Mountain Research Station, J.F. Kelly et al. \$14,000

Professional Activities

Local organizing committee member - 2001 Cooper Ornithological Society Meeting
 Organizing a grassland bird symposium - 2001 Cooper Ornithological Society Meeting
 Member of the Restoration Ecology Working Group of the Wildlife Society
 American Ornithologists= Union - Conservation Committee Member - 1997-2001
 Manuscripts Reviewed for *Ecology*, *Auk*, *Condor*, *Journal of Wildlife Management*,
American Midland Naturalist, *Wilson Bulletin*
 Proposal Review for the Center for Field Studies
 1993-1994 - President, Colloquium In Life Sciences, Colorado State University
 1992-1993 - Treasurer, Colloquium in Life Sciences, Colorado State University
 1990-1991 - Graduate Student Representative, Dept. of Zoology, Oklahoma State Univ.

Publications (1996-2000)

- Schooley, R.L., B. T. Bestelmeyer, and **J.F. Kelly**. 2000. Influence of small-scale disturbances by kangaroo-rats on Chihuahuan Desert ant communities. *Oecologia* 125:142-149.
- Kelly, J.F. and D.M. Finch. 2000. Effects of sampling design on age ratios of migrants captured at stopover sites. *Condor* 102:699-702.
- Kelly, J. F., D. M. Finch, and W. Yong. 2000. Vegetative associations of wood warblers migrating along the Middle Rio Grande Valley, New Mexico. *Southwestern Naturalist* 45:159-168.
- Cartron, J-L, **J.F. Kelly**, and J. H. Brown. 2000. Relationships among clutch size, body size and latitude: sorting out the paradox in strigid owls. *Oikos* 90:381-390.
- Brown, J. H., E. J. Bedrick, S. K. M. Ernest, J-L. E. Cartron, and **J. F. Kelly**. *In Press*. Constraints on negative relationships: mathematical causes and ecological consequences. In (M. Taper, L. Subhash and N. Lewin-Koh eds.) *The Nature of Scientific Evidence*. Univ. of Chicago Press.
- Kelly, J.F. 2000. Stable isotopes of carbon and nitrogen in the study of avian and mammalian trophic ecology. *Canadian Journal of Zoology* 78:1-27.
- Kelly, J.F. 1999. [Review of] *Population Limitation in Birds* by Ian Newton. *Auk* 116:866-868.
- Kelly, J. F., R. Smith, D. M. Finch, F.R. Moore, W. Yong. 1999. Effects of summer biogeography on the stopover abundance of Wood Warblers. *Condor* 101:76-85.
- Yong, W., D. M. Finch, F.R. Moore, and **J.F. Kelly**. 1998. Stopover ecology and habitat use of migratory Wilson=s Warblers. *Auk* 115:829-842.
- Kelly, J. F. 1998. Latitudinal variation in sex ratios of Belted Kingfishers. *Journal of Field Ornithology* 69:386-390.
- Kelly, J. F. and D. M. Finch. 1998. Using stable isotopes to track migrant songbirds. *trends in Ecology and Evolution* 13:48-49.
- Kelly, J. F. 1998. Behavior and energy intake of Belted Kingfishers in winter. *Journal of Field Ornithology* 69:75-84.
- Kelly, J. F. and B. Van Horne. 1997. Effects of supplemental food on timing of nest-initiation in Belted Kingfishers. *Ecology* 78:2504-2511.

- Kelly, J. F. and B. Van Horne. 1997. Effects of scale-dependent variation in ice cover on the distribution of wintering Belted Kingfishers. *Ecography* 20:506-512.
- Shields, S. J. and **J. F. Kelly**. 1997. Nest-site selection by Belted Kingfishers in Colorado. *American Midland Naturalist*. 137:401-403.
- Kelly, J.F. 1996. Effects of substrate on prey use by Belted Kingfishers: an experimental test of the prey abundance-availability assumption. *Canadian Journal of Zoology*. 74:693-697.

Technical Reports, Symposia, and Proceedings

- Periman, R. And **J.F. Kelly**. 2000. Historical survey of Willow Flycatcher habitat in the Southwest. Pages 25-42 *in* (Finch, D.M., and S.H. Stoleson, eds.) *Ecology and Conservation of the Southwestern Willow Flycatcher*. RMRS-GTR-60. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station
- Finch, D.M., **J.F. Kelly**, and J-L., E. Cartron. 2000. Migration and Winter Ecology. Pages 71-82 *in* (Finch, D.M., and S.H. Stoleson, eds.) *Ecology and Conservation of the Southwestern Willow Flycatcher*. RMRS-GTR-60. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station
- Finch, D. M., J. W. Whitney, **J. F. Kelly**, and S. R. Loftin. Technical editors . 1999. *Rio Grande ecosystems: linking land, water, and people*. 1998, June 2-5 Albuquerque, NM. RMRS-P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Kelly, J. F. and D. M. Finch. 1999. Use of saltcedar vegetation by landbirds migrating through the Bosque del Apache National Wildlife Refuge. Pages 222-231 *in* (Finch, D.M., J. W. Whitney, J. F. Kelly, and S. R. Loftin. eds.) *Rio Grande ecosystems: linking land, water, and people*. 1998, June 2-5 Albuquerque, NM. RMRS-P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Finch, D. M. and **J. F. Kelly**. 1999. Status and migration of the Southwestern Willow Flycatcher in New Mexico. Pages 197-203 *in* (Finch, D. M., J. W. Whitney, J. F. Kelly, and S. R. Loftin. eds.) *Rio Grande ecosystems: linking land, water, and people*. 1998, June 2-5 Albuquerque, NM. RMRS-P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Delay, L.S., D.M. Finch, S. Brantley, R. Fagerlund, M.D. Means, and **J.F. Kelly**. 1999. Arthropods of native and exotic vegetation and their association with Willow Flycatchers and Wilson=s Warblers. Pages 216-221 *in* (Finch, D. M., J. W. Whitney, J. F. Kelly, and S. R. Loftin. eds.) *Rio Grande ecosystems: linking land, water, and people*. 1998, June 2-5 Albuquerque, NM. RMRS-P-7. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

CURRICULUM VITAE
BURTON PENDLETON
Research Ecologist
Rocky Mountain Research Station,
333 Broadway SE, Albuquerque, NM 87102

Degrees and Professional History:

B.S., Brigham Young University, 1976, Botany
M.S., Brigham Young University, 1980, Botany/Ecology
Ph.D., Wayne State University, 1990, Biology/Evolution, Systematics and Ecology

Adjunct Assistant Research Professor, Brigham Young University, 1990-present.
Research Ecologist GS-408-11, Rocky Mountain Research Station, USDA FS, 1990-1994.
Research Ecologist GS-408-12, Rocky Mountain Research Station, USDA FS, 1994-present.
Instructor (Genetics), Utah Valley State College, 1995-1996.

Professional Affiliations:

Ecological Society of America, member, 2000.
Botanical Society of America, member, 1986-present.
Society for Range Management, member, 1991-1996.
Society of the Sigma Xi, 1982, 1990.
Canyon Country Ecological Research Site, Rocky Mountain Station technical representative, 1999-present

Areas of Research Interest: Plant reproductive ecology; plant community ecology; plant recruitment and establishment in arid ecosystems.

Research Grants (last 4 years):

09-Feb-96; Benefit of Microphytic Crust Inoculation and Arbuscular Mycorrhizal Fungi on Productivity of VAM-dependent Forbs; R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory; \$28,212; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

21-April-97; Microphytic Crust Biology: Evaluation of Algal Inoculation Effectiveness; R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory, \$9,000; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

09-Sept-98; Microphytic Crust Biology: Effect of Alginate Carrier on Plant Survival;

R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory, \$9,000; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

Refereed Journal Publications (last 4 years):

Pendleton, B. K., and R. L. Pendleton. 1998. Pollination biology of *Coleogyne ramosissima* (Rosaceae). *Southwestern Naturalist* 43:376-380.

Buttars, S. M, L. L. St. Clair, J. R. Johansen, J. C. Sray, M. C. Payne, B. L. Webb, R. E. Terry, B. K. Pendleton, and S. D. Warren. 1998. Pelletized cyanobacterial soil amendments: laboratory testing for survival, escapability, and nitrogen fixation. *Arid Soil Research and Rehabilitation* 12:165-178.

Other Publications (last 4 years):

Pendleton, R. L., B. K. Pendleton, and S. D. Warren. 1999. Response of blackbrush (*Coleogyne ramosissima*) seedlings to inoculation with arbuscular mycorrhizal fungi. p. 245-251 in E.D. McArthur, W. K. Ostler, C. L. Wambolt, comps. *Proceedings: shrubland ecotones; 1998 August 12-14; Ephraim, UT. Proc. RMRS-P-11. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.*

Pendleton, R. L., B. K. Pendleton, S. D. Warren and G. L. Howard. 2000. Response of blackbrush seedlings to dual inoculation with arbuscular mycorrhizal fungi and microbiotic soil crust organisms. Champaign, IL: U.S. Army Corps of Engineers, Construction Engineering and Research Laboratory.

Pendleton, B. K. In press. *Coleogyne*. In: *Seeds of Woody Plants in the United States*, 2nd ed. U.S. Department of Agriculture, Forest Service. Agriculture handbook.

CURRICULUM VITAE
ROSEMARY L. PENDLETON
Research Ecologist,
Rocky Mountain Research Station
333 Broadway SE, Albuquerque, NM 87102

Degrees and Professional History:

B.S., Brigham Young University, 1978, Botany
M.S., Brigham Young University, 1980, Range Science
Ph.D., Wayne State University, 1986, Biology/Plant Ecology

Research Ecologist GS-408-9, Intermountain Research Station, USDA FS, 1985-1986.

Research Ecologist GS-408-11, Intermountain Research Station, USDA FS, 1986-1990.

Research Ecologist GS-408-12, Rocky Mountain Research Station, USDA FS, 1990-present.

Adjunct Assistant Research Professor, Brigham Young University, 1986-present.

Professional Affiliations:

Ecological Society of America, member, 2000.

Botanical Society of America, member, 1986-present.

Society for Range Management, member, 1986 to 1996; Councilor, Utah Section, 1990-1991; Information and Education Committee member and chair, Utah Section, 1987-1989; Utah Range Camp Planning Committee, 1990; Workshop Co-Chair, Summer Meeting and Tour, Utah Section, 1992.

Phi Kappa Phi, 1978-1983.

Areas of Research Interest: Plant reproductive biology and establishment ecology; plant-soil relations; ecology of vesicular-arbuscular mycorrhizae.

Research Grants (last 4 years):

09-Feb-96; Benefit of Microphytic Crust Inoculation and Arbuscular Mycorrhizal Fungi on Productivity of VAM-dependent Forbs; R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory; \$28,212; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

21-April-97; Microphytic Crust Biology: Evaluation of Algal Inoculation Effectiveness; R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory, \$9,000; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

09-Sept-98; Microphytic Crust Biology: Effect of Alginate Carrier on Plant Survival; R. L. Pendleton and B. K. Pendleton, USDA FS Intermountain Research Station, Shrub Sciences Laboratory, \$9,000; one year; U.S. Army Corps of Engineers, Construction Engineering Research Laboratory.

Refereed Journal Publications (last 4 years):

Pendleton, B. K., and R. L. Pendleton. 1998. Pollination biology of *Coleogyne ramosissima*. Southwestern Naturalist 43:376-380.

Tarkalson, D. D., R. L. Pendleton, V. D. Jolley, C. W. Robbins, and R. E. Terry. 1998. Preparing and staining mycorrhizal structures in dry bean, sweet corn, and wheat using a block digester. Communications in Soil Science and Plant Analysis 29:2263-2268.

Pendleton, R. L., D. C. Freeman, E. D. McArthur, and S. C. Sanderson. 2000. Gender specialization in heterodichogamous *Grayia brandegei* (Chenopodiaceae): evidence for an alternative pathway to dioecy. American Journal of Botany 87:508-516.

Meyer, S. E., and R. L. Pendleton. In press. Genetic regulation of seed dormancy in *Purshia tridentata* (Rosaceae). Annals of Botany.

Pendleton, R. L. In press. Pre-inoculation with an arbuscular mycorrhizal fungus affects male reproductive output of buffalo gourd. International Journal of Plant Science.

Other Publications (last 4 years):

Pendleton, R. L., S. D. Nelson, and R. L. Rodriguez. 1996. Do soil factors determine the distribution of spineless hopsage? p. 205-209 in J.R. Barrow, E.D. McArthur, R.E. Sosebee, and R.J. Tausch, eds., Proceedings: shrubland ecosystem dynamics in a changing environment. U.S. Department of Agriculture, Forest Service, Intermountain Research Station General Technical Report INT-GTR-338, Ogden, UT.

Pendleton, R. L., and S. D. Warren. 1996. The effects of cryptobiotic soil crusts and VA mycorrhizal inoculation on growth and nutrient content of five rangeland plant species. p. 436-437. In: N.E. West (ed.), Rangelands in a sustainable biosphere - proceedings of the Fifth International Rangeland Congress. 1995 July 23-28; Salt Lake City, UT. Denver, CO: Society for Range Management.

Pendleton, R. L., B. K. Pendleton, and S. D. Warren. 1999. Response of

blackbrush (*Coleogyne ramosissima*) seedlings to inoculation with arbuscular mycorrhizal fungi. p. 245-251 in E.D. McArthur, W.K. Ostler, C.L. Wambolt, comps. Proceedings: shrubland ecotones; 1998 August 12-14; Ephraim, UT. Proc. RMRS-P-11. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 299 p.

Pendleton, R. L., B. K. Pendleton, S. D. Warren and G. L. Howard. 2000. Response of blackbrush seedlings to dual inoculation with arbuscular mycorrhizal fungi and microbiotic soil crust organisms. Champaign, IL: U.S. Army Corps of Engineers, Construction Engineering and Research Laboratory.

Leidolf, A., M. L. Wolfe, and R. L. Pendleton. 2000. Bird Communities of Gambel Oak: a descriptive analysis. General Technical Report RMRS-GTR-48. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 30 p.

COLLABORATIVE AND/OR SUBCONTRACTUAL ARRANGEMENTS

An interagency agreement between two USDA agencies will be used to transfer funds from U.S. Forest Service RMRS to NRCS Los Lunas Plant Materials Center (PMC) to complete revegetation work identified in this proposal. Local ecotype shrub vegetation will be planted by NRCS on 4 of the 20-ha treatment plots. Greg Fenchel is our NRCS contact and his CV is enclosed. Because the Rio Grande Valley receives less than 20 cm of annual moisture, the vegetation will be installed as dormant 4.5 m pole cuttings or as containerized transplants with 74 cm rootstock. This vegetation will be planted in holes that have been augured to the capillary fringe of the water table. Subsequently, the plants should not require any irrigation treatments, which is normally required for one-gallon transplants to obtain satisfactory survival. To adequately reach subsurface moisture, the relatively short 75 cm rootstock will be limited to planting near the river. The 4.5 m cuttings can be planted randomly within the plots.

PMC has determined in previous studies that the common Rio Grande riparian shrub species *Amorpha fruticosa* and *Baccharis glutinosa* can be field-established as dormant pole cuttings. The PMC has local collections of both species in farm production. The Rio Grande riparian shrub species *Lycium spp.* and *Forestiera neomexicana* are grown in 10-cm diameter tubes, 75 cm in length, to produce long root systems that can reach subsurface moisture after transplanting.

For enhancement of vegetation establishment, both soil salinity and depth to water table measurements will be taken on each of the 20-ha study plots. Each plot will be divided into quadrants. A well will be installed in the approximate center of each quadrant to monitor the water table depth. A composite sample of 30 soil samples taken from a 15 – 25 cm depth will be collected in each quadrant and measured for electrical conductivity to estimate total soil salts. Extreme salty and dry areas will not be planted. The PMC will contribute \$20,000 of in-kind services of plant materials and personnel hours towards this project. This will include the 75 cm tube transplant (@\$20/unit), 4.5 m pole cuttings (@\$8/unit), and personnel hours (@\$250/day). The PMC has the equipment and experience to install shallow monitoring wells and measure soil salinity.

COLLABORATOR RESUMES

Greg Fenchel

Received a B.S. degree in Range Management (1980) and a M.S. in Natural Resources with emphasis in Soil Science (1985) from Humboldt State University in California. While attending college, worked seasonally for the Bureau of Land Management as a Range Technician in Nevada and Wyoming. Also worked seasonally for AMFAC Nurseries in California as a student intern learning commercial horticulture production.

Has been employed by the USDA Natural Resources Conservation Service Plant Materials program since 1985, and subsequently worked at three Plant Material Centers: Colorado, Texas, and New Mexico. Duties have included all PMC activities, from farm maintenance to field study and evaluation. Current duties include promoting New Mexico's PMC program to potential cooperators for generating new resources. Areas of expertise include reclamation of disturbed lands such as surface coal mines, riparian areas, and range lands.

Greg Fenchel's Personal Publications include:

Restoration of Riparian Areas on Minelands Using Native Vegetation, presented at the Colorado Riparian Association October 5-7, 1995, Alamosa Colorado.

Overview of Riparian Restoration in New Mexico, presented at the International Erosion Control Association February 15-18, 1994, Reno Nevada.

Effects of Topsoil Dressing over Mine Spoil on Establishment of Vegetation at San Juan Mine, Northwestern New Mexico, presented at the eighth National Meeting ASSMR May 14-15, 1991, Durango, Colorado.

Establishment and Propagation Techniques For Cottonwood and Black Willows For Use in Southwestern Riparian Restoration, Presented at the Western Region Riparian Resource Management Workshop, May 8-11, 1989, Billings, Montana.

The Distribution of Marine Wind-Borne Sodium, Calcium, and Magnesium and it's Effect on Forage Nutrition in the Arcata Bottom and Mad River Area, Presented at International SRM meeting February 8, 1988 in Orlando, Florida.

Charles P. Wicklund,

I received my BS-Forestry from Northern Arizona University in 1965. I served two years in the Army with a one-year tour in Vietnam including the 68 TET offensive. Upon return went to work for private industry in forestry and lumber manufacturing.

The State of New Mexico, Forestry Division, has employed me since 1992. I have worked as Fire Management Officer on the Capitan District, and in fire and timber on the Socorro District. I was the Timber Management Officer on the Bernalillo District and participated in numerous bosque fires while in Bernalillo. When Legislation was passed to establish the Inmate Work Camp program in Los Lunas, I became the first IWC Camp Supervisor.

I transferred to Santa Fe as the Inmate Work Camp Program Manager. It was during this time that I became one of the authors of the "Prescription Guide to the Rio Grande Bosque". I have continued to update the guide over the past two years. I'm now the Forest Management Officer for the State of New Mexico. Presently, I'm working on a photo guide to help determine fuel loading in tons per acre of dead and down material in the bosque. This guide will allow land managers to identify and prioritize areas for hazardous fuel reduction.

Yasmeen Najmi
415 11th Street, NW, Albuquerque NM 87102

(505) 242-2085

Candidate for Masters Degree in Community and Regional Planning - Natural Resource Planning Emphasis, University of New Mexico. Professional Project title: *The Middle Rio Grande Conservancy District and Bosque Management: A Framework and Approach for Restoration Projects.* Expected graduation in May 2000.

Other Education: State University of New York at Buffalo, BA in Political Science, 1990
Experience:

February 2000 – Present

Assistant Planner and Reclamation Reform Act Coordinator

Middle Rio Grande Conservancy District (MRGCD), Albuquerque NM

Develops the Bosque Management Master Plan and coordinates the planning process for 30,000 acres of riparian forest within the MRGCD. Coordinates planning, management and monitoring of bosque rehabilitation and fire management projects and associated endangered species issues. Develops programs, projects and policies with MRGCD staff and other entities and agencies. Serves as the MRGCD's Reclamation Reform Act Administrator and Land Sales Coordinator.

October 1997 – February 2000

Planning Intern

Middle Rio Grande Conservancy District, Albuquerque NM

Developed a Conceptual Bosque Management Master Plan for review and outlined a planning process for 30,000 acres of riparian forest within the MRGCD. Coordinated planning, management and monitoring of bosque rehabilitation and fire management projects and associated endangered species issues. Developed programs, projects and policies with MRGCD staff and other entities and agencies.

October 1996- March 1997

Research Assistant, National Parks Conservation Association

Southwest Regional Office, Albuquerque, NM

Reviewed and commented on management plans and Environmental Impact Statements from the National Park Service (NPS) and other agencies pertaining to the operation of NPS units. Formulated a draft scenic byway proposal for highways accessing the Grand Canyon's South Rim. Developed position papers to address management concerns in NPS units in the Southwestern United States.

September 1994 - **August 1996**

Recreation Technician (GS-5) and AmeriCorps National Service Volunteer

Bureau of Land Management, Taos Field Office, Taos NM

Assisted a bi-state planning team in developing a Coordinated Management Plan and Environmental Impact Statement for 90 miles of the Rio Grande Corridor in Colorado and New Mexico. Compiled recreation data and developed use projections and trends to support plan alternatives. Designed and implemented a river recreation monitoring program.

Ondrea C. Linderorth-Hummel

**4720 Plume NW
Albuquerque, NM 87120
(505) 898- 8390**

EDUCATION

University of New Mexico; Albuquerque, NM; PhD Graduate Program: January 1998-Present;
Florida Institute of Technology, Melbourne, FL; **MS Biological Sciences: 1994**
Keuka College, Keuka Park, NY; **BA Biology: 1992**

WORK EXPERIENCE

City of Albuquerque, Open Space; 3615 Los Picaros Rd. SE; Albuquerque, New Mexico, 87105

Supervisor: Matt Schmader, (505)873-6620

Program Manager, March 1999 to present

- Oversee daily functions of Resource Management and Visitor Services Section including facility management, planning, environmental education and biological monitoring
- Oversee management of Open Space Visitor Center including implementation of Visitor Center plan
- Supervise 15 employees; review documentation, projects, etc. developed by staff
- Perform evaluations of natural and cultural resources on Open Space lands for planning and management
- Perform biological and cultural resource inventories, damage assessments, make management recommendations
- Create environmental documentation displaying management and monitoring data; coordinate with academic and scientific community
- Point of contact for all projects conducted on Open Space lands; maintain database of projects
- Implement existing management plans and review present conditions prior to implementation; pursue funding
- Maintain familiarity with City of Albuquerque Open Space Network (currently 28,000 acres) and all projects taking place on these lands
- Develop interpretive displays, brochures and newsletters to educate public of the Open Space Program
- Develop Resource Management Plans, Master Plans, or Site Plans for new properties as dictated in the *Major Public Open Space Facility Plan*; facilitate public participation
- Develop and implement wetland and riparian restoration projects on Open Space lands

City of Albuquerque, Open Space; 3615 Los Picaros Rd. SE; Albuquerque, New Mexico, 87105

Supervisor: Matt Schmader, (505)873-6620

Natural Resource Planner/Biologist, July 1995 – March 1999

- Oversee daily planning and biological monitoring programs
- Supervise three employees
- Perform evaluations of natural and cultural resources of Open Space lands for planning and management purposes

U.S. Fish and Wildlife Service; P.O. Box 2676; Vero Beach, Florida 32961

Supervisor: Craig Johnson, (407)562-3909

Fish and Wildlife Biologist, January 1995 to June 1995

- Conducted field investigations and literature reviews to collect data on fish and wildlife resources
- Predicted probable impacts of proposed development projects on fish and wildlife resources
- Reported probable impacts to U.S. Army Corps of Engineers through permit review process
- Participated in local monitoring projects including water, sediment and habitat quality of the Indian River Lagoon and adjoining Atlantic Ocean system

PROFESSIONAL DEVELOPMENT AND SKILLS

- Received training certification in:
 - Public Speaking
 - Advanced Public Speaking

- Supervisor Training
- Train the Trainer Academy
- Meeting Facilitation Training
- Introduction to GIS/Intermediate GIS
- Computer skills include Windows 95/98, WordPerfect 6.0-8.0, Office 1998/2000: Microsoft Word, MS PowerPoint, MS Excel, MS Publisher; Adobe- PageMaker, Reader/Distiller, PhotoShop LE, Illustrator; Corel Photo, HP Desk scan, Netscape, Internet Explorer, Beginning skills in Arc: Arc Info, Arc Plot, Arced it

PUBLICATIONS

“Seagrass Coverage and Diversity Changes due to Mosquito Impoundment Influences in Selected Impoundments in the North Indian River Lagoon, Brevard County, Florida” **1994. Unpublished Master’s Thesis, Florida Institute of Technology.**

“San Antonio Oxbow Biological Management Plan” **1997. City of Albuquerque, Open Space Div.**

“Candelaria Farm Preserve Management Plan” Draft, 1998. City of Albuquerque, Open Space Div.

“Analysis of the Groundwater Monitoring Program in the Rio Grande Valley State Park, January 1996 through December 1997” 1998. E. Cordova and O. Linderth.

“Restoration Efforts in the Rio Grande Valley State Park, Albuquerque, NM” 1998. Rio Grande Ecosystem Conference Proceedings

“Las Huertas Creek Watershed Management Plan” 1998. UNM Watershed Management Planning class.

“The Riparian Zone” Newsletter of the New Mexico Riparian Council. Design layout and **Co-Editor**

“Open Space News” Newsletter of Open Space Division/Open Space Alliance. **Editor**

Rio Grande Valley State Park Trail Map, Sandia Foothills Trail Map
Government 16 Shows: What is Open Space?, Managing the Bosque, Prairie Dogs in Open Space, Open Space
Visitor Center, Fuel Reduction in the Bosque

PRESENTATIONS

- ◆ “Balancing Public Amenities with Natural Resource Protection” 1997. New Mexico Parks and Recreation Association Conference
- ◆ “Management of the Rio Grande Valley State Park, Albuquerque, NM” 1998. New Mexico Riparian Council Conference
- ◆ “Volunteerism in the Rio Grande Valley State Park, Albuquerque, NM” 1998. Partnerships for the Future Conference
- ◆ “Restoration Efforts in the Rio Grande Valley State Park, Albuquerque, NM” 1998. Poster presentation. Rio Grande Ecosystems: Linking Land, Water and People Conference

PROFESSIONAL AFFILIATIONS

New Mexico Riparian Council, President, October 1999 – October 2000.

Open Space Alliance. Board Member, Project Committee Chair, October 1998 to Present.

New Mexico Recreation and Parks Association. 1997 Conference Planning Team.
Rio Grande/Rio Bravo Basin Coalition *New Mexico Volunteers for the Outdoors*
New Mexico Mountain Biking Club *Ecological Society of America*

HONORS

International Who's Who of Professionals. November 1997.

Annual Employee Appreciation Award, Open Sp

JOHN P. TAYLOR

U.S. Fish and Wildlife Service PH: (505) 835-1828
P.O. Box 1246 FX: (505) 835-0314
Socorro, New Mexico 87801 EM: John_P_Taylor@fws.gov

Education and Work Experience

B.S. Wildlife Science, New Mexico State University, 1980
M.S. Wildlife Management, Texas Tech University, 2000

1976-1978 Range Aid: Jornada Experimental Range USDA/NMSU, Jornada, N.M.
I conducted range evaluation and utilization surveys. I was involved in ranch maintenance and cattle management.

1978 Biological Aid: Crab Orchard National Wildlife Refuge, ILL.
1979 Biological Aid: Sherburne National Wildlife Refuge, MN.
I conducted wildlife censusing and waterfowl management programs. I participated in prairie restoration activities including plantation timber logging and prescribed burning.

1981 Asst. Refuge Manager: Minnesota Valley National Wildlife Refuge, MN.
1982 Asst. Refuge Manager: Litchfield Wetland Management District, MN.
I planned and developed newly created portions of the refuge/district which included wetland, riparian, and prairie restoration programs. I coordinated biological studies including grassland evaluation, satellite wetland characteristics and waterfowl breeding response.

1983-1985 Refuge Manager: Culebra National Wildlife Refuge, Puerto Rico
I managed a 1500 acre refuge consisting of islands and beaches for 12 species of seabirds and 4 species of endangered sea turtles. I developed seabird monitoring programs and analyzed population structures and

trends. I developed habitat improvement programs which arrested population declines. I initiated sea turtle nesting surveys on 8 area beaches which resulted in the recognition of a significant unique leatherback turtle nesting population.

1986-present Wildlife Biologist, Bosque del Apache National Wildlife Refuge, N.M.

I am responsible for migratory bird management, wetland management, riparian management, water management, and research and monitoring on the 57,000 acre Bosque del Apache WNR. I frequently work outside refuge boundaries serving as a regional consultant for these management activities throughout the Middle Rio Grande corridor of new Mexico extending from Cochiti Pueblo to El Paso, Texas. I serve on regional management committees involved with migratory bird management and riparian management and I am the field representative for the North American Waterfowl and Wetlands Office reviewing wetland conservation initiatives in the Rio Grande corridor and in the Interior Highlands of Mexico. Involvement in these activities has allowed the formation of close contacts with American, Canadian, and Mexican biologists assessing our management actions on bird movements regionally and internationally through marking and resighting program research.

Responsibilities for migratory bird management include assuring habitat needs for light geese, sandhill cranes, other waterfowl, waterbirds, shorebirds, and migratory passerine species are met. Winter bird management activities involving cranes and waterfowl are considered among the most intensive in the world, maximizing a limited wetland and cropland habitat base for high numbers of birds. Other aquatic bird species management centers on expanding waterbird rookery and feeding habitats and maximizing quality migratory shorebird habitats.

Responsibilities for wetland management involve refining recognized moist soil management practices regionally for use by other area managers. Through intensive management practices, wetland food production and habitat needs are expanding for wetland dependent wildlife. Migratory bird use has increased 5 fold since initiation of intensive management practices. Our wetland management system is now considered a model for use regionally. I conduct research programs focusing on wetland food plant production techniques.

Responsibilities for riparian management center on the maintenance and restoration of the cottonwood/willow dominated forest on the refuge. I coordinate research and monitoring programs on the refuge dealing with the effects of seasonal flooding on flora and fauna. I coordinate riparian restoration programs both on and off the refuge dealing with exotic flora control, revegetation, and natural forest regeneration using flood management.

Peer Reviewed Publications:

Taylor, J.P. and R.E. Kirby. 1990. Experimental dispersal of wintering snow geese and Ross' geese. *Wildlife Society Bulletin*. 18:312-319.

Sheets, K.R., Taylor, J.P., and J.M.H. Hendrickx. 1994. Rapid salinity mapping by electromagnetic induction for determining riparian restoration potential. *Restoration Ecology*. 2:242-246.

Post, D.M., Taylor, J.P., Kitchell, J.F., Olson, M.H., Schindler, D.E., and B.R. Herwig. 1998. The role of migratory waterfowl as nutrient vectors in a managed wetland. *Conservation Biology*. 12:910-920.

Taylor, J.P. and K.C. McDaniel. 1998. Restoration of saltcedar infested floodplains on the Bosque del Apache national wildlife refuge. *Weed Technology*. 12:345-352.

Taylor, J.P. and K.C. McDaniel. 1998. Riparian management on the Bosque del Apache national wildlife refuge. *New Mexico Journal of Science*. 38:219-232.

Taylor, J.P., Wester, D.B., and L.M. Smith. 1999. Soil disturbance, flood management, and riparian

woody plant establishment in the Rio Grande Floodplain. *Wetlands*. 19:372-382.

Armstrong, W.T., Meeres, K.M., Kerbes, R.H., Boyd, W.S., Silveira, J.G., Taylor, J.P., and B. Turner. 1999. Routes and timing of migration of lesser snow geese from the Western Canadian Arctic and Wrangel Island, Russia, 1987-1992. Pages 75-88 in R.H. Kerbes, K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Occasional Paper Number 98. Canadian Wildlife Service, Ottawa, Ontario, Canada.

Hines, J.E., Baranyuk, V.V., Turner, B., Boyd, W.S., Silveira, J.G., Taylor, J.P., Barry, S.J., Meeres, K.M., Kerbes, R.H., and W.T. Armstrong. 1999. Autumn and winter distribution of less snow geese from the Western Canadian Arctic and Wrangel Island, Russia, 1953-1992. Pages 39-74 in R.H. Kerbes, K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Occasional Paper Number 98. Canadian Wildlife Service, Ottawa, Ontario, Canada.

Hines, J.E., Wiebe, M.O., Barry, S.J., Baranyuk, V.V., Taylor, J.P., McKelvey, R., Johnson, S.R., and R.H. Kerbes. 1999. Survival rates of lesser snow geese in the Pacific and Western Central flyways, 1953-1989. Pages 89-110 in R.H. Kerbes, K.M. Meeres, and J.E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Occasional Paper Number 98. Canadian Wildlife Service, Ottawa, Ontario, Canada.

RESUME

Jim Sullivan

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Fax: 505-627-9414
E-mail: jim_sullivan@fws.gov

EDUCATION

B.S. 1978 - Environmental Resource Management, Arizona State University

EXPERIENCE

US Forest Service - 1974-1983, 1985-1986, Tonto National Forest
- 1986-1988, Coconino National Forest
- 1993-1994, Olympic National Forest

US Park Service - 1989-1991, Grand Canyon National Park
- 1991-1992, Yosemite National Park
- 1995-1996, Guadalupe Mountains National Park

US Fish and Wildlife Service - 1998-2000, Bitter Lake National Wildlife Refuge

The Nature Conservancy - 1984, Muleshoe Ranch Preserve

Jim has been involved in fire suppression and fire management for over 25 years, since initiating Grand Canyon as a pilot Park for the Western Region Fire Monitoring program, he has been actively involved in fire effects monitoring.

RICHARD SCHWAB

POSITION: Regional Assistant Fire Management Officer

ADDRESS: Bureau of Indian Affairs
Southwest Regional Office
P.O. Box 26567
Albuquerque, New Mexico 87125
(505) 346-7579 Office, (505) 346-7539 Fax
Richardschwab@bia.gov

DUTIES:

- Assists in the preparation, review, and updating of the Regional and Agency Fire Management Planning Analysis (FMPA). Insures that program expenditures and staffing are in compliance and consistent with approved FMPA budgets.
- Assists in the development and negotiation of cooperative fire agreements within the Area with various Federal, Tribal, State, and private fire management agencies and organizations.
- Assists in conducting activity reviews and technical assistance trips to Agency units to evaluate compliance with policies, objectives, standards, and overall effectiveness of operations. Provides technical assistance in the solution of specific local problems. Recommends changes in operational procedures to increase effectiveness and efficiency of operations, and to provide technical assistance in the solution of specific local problems. Recommends changes in operation procedures to increase effectiveness or to correct practices in violation of established regulations or procedures.
- Coordinates studies in such areas as fire prevention, fire behavior, fire spread, fire effects, resistance factors, fire retardant, fuels, weather and related fire management factors. Works with research personnel in the development and trial of new methods and approaches for fire management activities.
- Provides assistance and guidance in the planning, implementation, and oversight of incidental Burned Area Emergency Rehabilitation (BAER) activities within the Area.
- Makes on-the-ground reviews of suppression activity effectiveness on large fires. Assists in the planning and direction of administrative studies designed to analyze the effectiveness of new methods of combating wildfire and participates in the evaluation of new fire fighting equipment.
- Represents supervisor and Area Office on designated local, regional, and/or national interagency fire management committees and/or task groups.
- Assists with the completion of all required correspondence including but not limited to project proposals and accomplishment reports related to the fire program.

EDUCATION: Bachelor of Science Degree, Northern Arizona University, May 1981

APPENDIX

Detailed Budget	Cooperators	RMRS	JFSP
Year One			
P.I. Salaries (in-kind)	0	\$137,395	0
Field Crew Housing	\$5,000	0	0
Field Technician Salaries	0	22,000	\$42,020
Bat research equipment	\$5,000	0	\$ 5,000
Herp research equipment	0	\$2,500	\$ 2,500
Bird & day-arthropod equipment	0	0	\$ 3,250
Vegetation sampling equipment	0	0	\$ 5,000
Arthropod collection at night	0	0	\$ 2,000
Hydrology, soil, weather gear & labor	0	0	\$12,360
GSA Vehicle rental (two)	0	\$2000	\$ 4,000
Travel/Per Diem	0	0	\$ 6,000
Miscellaneous office supplies/software	\$300	\$500	\$ 500
Revegetation Equipment	0	0	\$16,700
SubTotal	\$10,300	\$164,395	\$99,330
Indirect Costs 12%	0	0	\$12,350
Total	\$10,300	\$164,395	\$111,680
Year Two			
P.I. Salaries (in kind)	0	\$114,774	\$28,107
Field Crew Housing	\$5,000	\$0	0
Field Technician Salaries	0	\$24,888	\$43,701
Arthropod Specialist – All ID work	0	0	\$ 6,000
Sampling Equipment	\$5,000	0	\$ 1,500
GSA Vehicle rental (two)	0	\$2,000	\$ 4,000
Travel/Per Diem	0	0	\$ 6,500
Miscellaneous office supplies/software	\$300	\$500	\$ 500
Revegetation Treatment	\$20,000	0	\$16,700
SubTotal	\$30,500	\$142,162	\$107,008
Indirect Costs 12%	0	0	\$ 14,382
Total	\$30,500	\$142,162	\$121,390
Year Three			
P.I. Salaries (in kind)	0	\$119,365	\$29,231
Field Crew Housing	\$5,000	\$0	0
Field Technician Salaries	0	\$24,888	\$43,701
Arthropod Specialist	0	0	\$ 6,000
Sampling Equipment	\$5,000	0	\$ 1,500
GSA Vehicle rental (two)	0	\$2,000	\$ 4,000
Travel/Per Diem	0	0	\$ 6,500
Miscellaneous office supplies/software	\$300	\$500	\$ 500

Revegetation Treatment	0	0	\$16,700
Publication Costs	0	\$10,000	0
SubTotal	\$15,300	\$156,753	\$108,132
Indirect Costs 12%	0	0	\$ 14,533
Total	\$15,300	\$156,753	\$122,665

Figure 1. Locations of the fuel reduction study sites in the middle Rio Grande

